Diagnostic accuracy of Uterine Artery Doppler Velocimetry in Patients with Placenta Previa

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Diagnostic Accuracy of Uterine Artery Doppler Velocimetry in Patients with Placenta Previa

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Abstract

Background: Placenta previa (PP) is an obstetric problem in which the placental tissue is improperly located inside the lower uterine segment.

Aim and objective: The aim was to see how effective uterine artery Doppler velocimetry was in detecting unusually morbidly adhering placentas in patients who had one or more prior cesarean sections with PP.

Patients and methods: A cross-sectional research on 100 patients was undertaken in the Department of Gynecology and Obstetrics, El-Sayed Galal Hospital, Al-Azhar University.

Results: This result showed a highly statistically significant correlation between the presence of abnormal lacunae and histopathological confirmation ($P > 0.001$). In addition, the overall sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were 90, 100, 100, 64.2, and 91.6%, respectively. This criterion showed very high sensitivity and specificity with very high positive predictive value and accuracy to become the most important criteria.

Conclusion: As a result of this, the authors conclude that the accuracy of abnormal placental lacunae, loss of the retro-placental clear zone, myometrial thinning, and uterovesical hypervascularity are the most critical ultrasound criteria for diagnosing placenta accreta in patients who had a previous cesarean section with a PP overlying the previous uterine scar.

Keywords: Diagnostic accuracy, Lower uterine segment, Placenta previa, Uterine artery Doppler, Velocimetry

1. Introduction

Because of the substantial increase in cesarean births during the last four decades, the problematic issue of aberrant placentation has become more clinically relevant in obstetric practice.[1]

Placenta previa (PP) is an obstetric problem in which the placental tissue is improperly located inside the lower uterine segment.[2]

The specific pathophysiology of this dangerous illness is unknown. Scarring of the uterus, on the contrary, is a possible risk factor. Advanced maternal age, high parity, a history of PP, and congenital uterine abnormalities are all risk factors for PP.[3]

PP is predicted to affect 5.2 per 1000 pregnancies, or ~0.5% of all pregnancies. Regional variation, on the contrary, is evident.[4] This incidence has risen during the last decade, owing to a higher cesarean section (CS) rate.[5]

The term 'placental accreta spectrum (PAS)' refers to all three conditions, according to the International Federation of Gynecology and Obstetrics 2018 agreement (accreta, increta, and percreta). The presence of a morbidly adherent placenta is a significant cause of maternal morbidity and death. Owing to uterine injury (due to prior surgery, cesarean births, curettage, and myomectomy), inadequate management allows the placenta to expand with nonexistent Nitabuch layer in myomectomy; PAS is usually associated with PP.[6]

Placenta accreta has been linked with a variety of sonographic abnormalities. In most situations, the existence of a PP causes the lower uterus to adhere to the prior cesarean operation. Myometrial thinning,

focal exophitic mass, bladder wall disruption, lacunar flow, diffuse lacunar flow, localized lacunar flow, subplacental vascularity, and uterovesical hyper-vascularity are some of the findings.[7]

Incorporating color Doppler ultrasonography provides a strong predictive potential for detecting myometrial invasion. Myometrial invasion is indicated when the space between the uterine serosal bladder interface and the retroplacental arteries is less than 1 mm and extensive retroplacental lacunae are seen.[8]

The purpose of this research was to see how effective uterine artery Doppler velocimetry is in detecting unusually morbidly adherent placentas in patients who had had one or more prior CSs with PP.

2. Patients and methods

This cross-sectional research on 100 patients was undertaken in the Department of Gynecology and Obstetrics, El-Sayed Galal Hospital, Al-Azhar University. Sample size justification: the EPI info 2000' is statistical software for epidemiology developed by Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia (US) statistical program was used to compute sample sizes. The original trial's sample size was computed using Amirabi *et al.*[8] with an incidence of roughly 22.1%, a power of 0.80, a type I error of 5%, a 90.6% sensitivity ratio, a 5% error level, and an accuracy of 4%, a sample size of 96 was considered. The sample size was estimated based on these parameters, and 96 instances were found to be sufficient. To account for dropouts and incomplete cases, the sample size was increased to 100 cases to ensure that this number is fulfilled in the analysis.

Inclusion criteria for study group were as follows: patients aged 20–40 years (childbearing age), pregnant women over 28 weeks of gestation who were identified with PP by 2D ultrasound (the US diagnosis of PP will be considered when the placental mass reaches the interior cervical os), women with singleton pregnancy, and patients who have had at least one CS.

Exclusion criteria for groups were as follows: patients with bleeding disorders or on anticoagulant therapy, systemic chronic diseases such as chronic liver diseases, chronic kidney disease, hypertensive patients, diabetes, complicated pregnancies like hypertension, diabetes mellitus, cardiac disease, polyhydramnios, and multifetal pregnancy and primigravida.

2.1. Methods

The eligible subjects included in this study were subjected to the following.

(1) Informed consent: it was obtained from all participants before they were enrolled in the research and after they were informed about the study's goals.
(2) Complete history taking: it included personal history, menstrual history, history of last menstruation period, obstetrics history, past history of medication and surgeries, and any complaints such as antepartum hemorrhage.
(3) Examination: general examination included signs of life (blood pressure, temperature, heart rate, and respiratory rate).
(4) Abdominal and local clinical examination: it included abdominal inspection, abdominal palpation (light palpation of the abdomen and deep palpation of the abdomen, abdominal percussion, and abdominal auscultation), and bimanual examination (bimanual evaluation was used to identify the uterus' size and type, as well as the occurrence or lack of adnexal masses).
(5) US evaluation: it was used for determining the fetal number, fetal biometry, Amniotic Fluid Index (AFI), fetal viability, and placental size and position in detail, as well as any signs indicating an improperly attached placenta.
(6) Doppler US diagnosis Doppler measurements: it was performed on the left and right uterine arteries, and the mean pulsatility index (PI) and resistive index (RI) were defined as the average of the two vessels.
(7) Decision making for the planned date of termination.
(8) In cases with PP and no signs of PAS disorders, pregnancy termination was scheduled at more than 37 weeks. Moreover, patients were categorized into groups with and without PAS disorders after surgery. All cases were delivered by CSs (either elective at term or emergency in case of attack of antepartum hemorrhage).

2.1.1. Perioperative preparations: complete blood picture

Preoperative preparation of cross-matched blood was done with at least 4 units of packed red blood cells. Counseling of the patient and her family was done for the possibility of incidence of CS hysterectomy, together with taking written consent for participation and consent for hysterectomy. Later on, the diagnosis was performed based on clinical operative findings and histopathological evidence provided by the surgical team or in hysterectomy cases, respectively.

2.1.2. Ethical consideration

The Al-Azhar University Institutional Review Board approved the study procedure. Each individual who took part in the research gave verbal informed permission. At all stages of the research, confidentiality and personal privacy were protected.

2.2. Data management and statistical analysis

Microsoft Excel software was used to code, input, and analyze data obtained during the history, basic clinical examination, laboratory tests, and outcome measures. The information was then entered into the Statistical Package for the Social Sciences (SPSS) (IBM SPSS statistics (Statistical Package for Social Sciences) software version 20.0, IBM Corp., Chicago, USA, 2013 and Microsoft Office Excel 2007). For analysis, the SPSS program was used.

3. Results

This was a prospective study performed at Gyn/Obs Hospital − Beni-Suef General Hospital during the time interval from November 2018 to May 2019. It included 100 pregnant women who presented to our outpatient clinic or casualty department with diagnosis of PP. All selected patients met the inclusion criteria and were further subdivided into two groups.

Of 100 patients, US suggested that 72 patients had placenta accreta and 28 had placenta nonaccreta. However, intraoperative assessment suggested that 56 patients had placenta accreta and 44 had placenta nonaccreta. Moreover, histopathological assessment showed that 51 patients (out of 60 specimens) had placenta accreta and nine did not have placenta accreta (Table 1).

The average age of the patients participating in the trial was 31.14 years, and the average gestational age was 36 weeks. The average number of CS was 2.59 (Table 2).

Table 1. Number of placenta accreta and placenta nonaccreta cases with ultrasound evaluation, intraoperative assessment, or histopathological pattern.

	Count	%
Ultrasound evaluation		
Accreta	72	72.0
Nonaccreta	28	28.0
Intraoperative assessment		
Accreta	56	56.0
Nonaccreta	44	44.0
Histopathological pattern		
Accreta	51	85.0
Nonaccreta	9	15.0

Table 2. Mean age, gestational age, parity, number of CS, and surgical evacuation among the patients included in the research.

	Mean	SD	Median	Minimum	Maximum
Age	31.14	5.01	32.00	20.00	40.00
GA	36.11	2.06	36.00	28.00	39.00
Parity	2.98	1.19	3.00	1.00	6.00
Number of CS	2.59	1.09	2.00	1.00	5.00
Number of SE	0.21	0.57	0.00	0.00	3.00

CS, cesarean section; GA, gestational age; SE, surgical evacuation.

Table 3. Comparing instances of placenta accreta group and placenta nonaccreta group regarding social status and history of postdelivery complications.

	Accreta (n = 51)		Non accrete (n = 49)		P value
	Count	%	Count	%	
Social status					
High	6	11.8	6	12.2	
Mid	24	47.1	27	55.1	
Low	21	41.2	16	32.7	0.666
H/O of postdelivery complications					
Wound infection	1	2.0	1	2.0	
Puerperal sepsis	1	2.0	0	0	
PP hemorrhage	2	3.9	0	0	
ICU admission	1	2.0	0	0	
Blood transfusion	0	0	2	4.1	
Bladder injury	0	0	1	2.0	0.493
No	46	90.2	45	91.8	

PP, placenta previa.

There was no statistically significant difference regarding social status of patients enrolled in the study. History of postpartum complications was observed and showed no statistical significance (Table 3).

Our results showed a highly statistically significant correlation between loss of clear zone and histopathological confirmation (P = 0.001). In addition, the overall sensitivity, specificity, positive predictive value (PPV), negative predictive value

Table 4. Significance of loss of clear zone by ultrasound and histopathological pattern.

	Histopathological pattern				P value
	Accreta (n = 51)		Non accrete (n = 9)		
	Count	%	Count	%	
Loss of clear zone					
Yes	42	82.4	2	22.2	0.001
No	9	17.6	7	77.8	
Statistic	%		95% CI		
Sensitivity	82.35		69.13—91.60		
Specificity	77.78		39.99—97.19		
Positive predictive value	95.45		86.00—98.63		
Negative predictive value	43.75		28.10—60.75		
Accuracy	81.67		69.56—90.48		

(NPV), and accuracy were 82.3, 77.7, 95.5, 43.7, and 81.6%, respectively. This criterion showed high sensitivity with very high PPV (Table 4).

Our results showed a highly statistically significant correlation between the presence of abnormal lacunae and histopathological confirmation ($P > 0.001$). In addition, the overall sensitivity, specificity, PPV, NPV, and accuracy were 90, 100, 100, 64.2, and 91.6%, respectively. This criterion showed very high sensitivity and specificity with very high PPV and accuracy to become the most important criteria (Table 5).

Our results showed no statistically significant correlation between the presence of placental bulge

Doppler) to identify placenta accreta in patients with PP.

Sensitivity, specificity, PPV, NPV, and accuracy were 90.2, 100, 100, 64.2, and 91.6% in correlation with histopathological evaluation, and 83.93, 81.8, 85.4, 80, and 83% in correlation with intraoperative evaluation, respectively.

A highly statistically significant difference was noticed between two groups, where 90% of cases with histopathological confirmation had abnormal lacunae versus 0% in the nonaccreta group.

Our study agreed with a study concluded by Maged et al.[9] at the same institute of our study, who found that the presence of abnormal lacunae

Test result variable(s)	Area under the curve	P value	95% confidence interval	
			Lower bound	Upper bound
Uterine artery Doppler PI	0.556	0.342	0.440	0.672
Uterine artery Doppler resistive index	0.511	0.855	0.390	0.632w

and histopathological confirmation ($P = 0.7$). In addition, the overall sensitivity, specificity, PPV, NPV, and accuracy were 47, 44.4, 82.7, 12.9, and 46.6%, respectively (Table 6).

Our results showed no statistically significant correlation regarding average values of uterine artery Doppler PI and RI between cases of placenta accreta and placenta nonaccreta by histopathological examination ($P = 0.078$ and 0.58, respectively) (Table 7 and Fig. 1).

4. Discussion

This study aims to measure the ability of Doppler US (either placental morphology or uterine artery

sensitivity was 93%, PPV was 80.82%, NPV was 85.19%, and accuracy was 82.00%.

Pilloni et al.[10] suggested the presence of abnormal lacunae with 94.6% specificity and with 48.6% sensitivity.

However, Cali et al.[11] found that the presence of abnormal lacunae showed sensitivity of 73.0% and specificity of 86.7%.

Yang et al.[12] found that the presence of abnormal lacunae showed sensitivity of 86.9%, specificity of 78.6%, PPV of 76.9%, and NPV of 88%. The total pooled sensitivity and specificity from 13 investigations of lacunar spaces detecting Morbid Adherent Placenta (MAP) were 77 and 95%,

Table 5. Significance of the presence of abnormal lacunae by ultrasound and histopathological pattern.

	Histopathological pattern				P value
	Accreta (n = 51)		Nonaccreta (n = 9)		
	Count	%	Count	%	
Abnormal lacunae					
Yes	46	90.2	0	0	<0.001
No	5	9.8	9	100.0	
Statistic		%	95% CI		
Sensitivity		90.20	78.59−96.74		
Specificity		100.00	66.37−100.00		
Positive predictive value		100.00			
Negative predictive value		64.29	43.91−80.54		
Accuracy		91.67	81.61−97.24		

Table 6. Significance of the presence of placental bulge by ultrasound and histopathological pattern.

	Histopathological pattern				P value
	Accreta (n = 51)		Nonaccreta (n = 9)		
	Count	%	Count	%	
Placental bulge					
Yes	24	47.1	5	55.6	0.727
No	27	52.9	4	44.4	
Statistic		%	95% CI		
Sensitivity		47.06	32.93−61.54		
Specificity		44.44	13.70−78.80		
Positive predictive value		82.76	71.42−90.22		
Negative predictive value		12.90	6.39−24.33		
Accuracy		46.67	33.67−60.00		

Table 7. Comparison between cases of placenta accreta group and placenta nonaccreta group regarding average values of uterine artery Doppler PI and RI in correlation with histopathological pattern.

	Histopathological pattern										P value
	Accreta (n = 51)					Nonaccreta (n = 9)					
	Mean	SD	Median	Minimum	Maximum	Mean	SD	Median	Minimum	Maximum	
Uterine artery Doppler PI	0.81	0.21	0.81	0.40	1.50	0.91	0.22	1.03	0.52	1.12	0.078
Uterine artery Doppler RI	0.54	0.12	0.52	0.32	0.80	0.58	0.17	0.52	0.39	0.81	0.583

RI, resistive index.

respectively, in a recent systematic review, with an overall predictive value of 88%.[13]

Abnormal placental lacunae have the highest accuracy among other criteria of US findings with high sensitivity and specificity.

In this research, histopathological evaluation had sensitivity, specificity, PPV, NPV, and accuracy of 82.35, 77.7, 95.4, 43.7, and 81.6%, respectively. In addition, the sensitivity, specificity, PPV, NPV, and accuracy were found to be 78.5, 88.6, 89.8, 76.4, and 83%, respectively, in association with intraoperative evaluation in our investigation.

Maged et al.[9] suggested the loss of retroplacental clear zone to have 87.3% sensitivity, 89.1% specificity, 93% PPV, 80% NPV, and 88% accuracy, which agreed with our study.

Pilloni et al.[10] suggested 81% sensitivity and 97% specificity to the retroplacental zone disruption.

The total pooled sensitivity and specificity from 13 investigations of loss of retroplacental clear zone diagnosing MAP were 66 and 95%, respectively, in a recent systematic review.

Wong et al.[14] reported that the lack of the clear area was discovered in 37 (65%) of women without placenta accreta and 100% of those with it. As a result, it is perceptive but not specific.

This study revealed sensitivity, specificity, PPV, NPV, and accuracy were 80.3, 42.9, 44.4% and 89, 28, and 75%, respectively, in correlation with histopathological assessment. In addition, our research revealed sensitivity, specificity, PPV, NPV, and accuracy were 80, 75, 80, 75, and 78%, respectively, in correlation with intraoperative assessment.

Our study agreed with Budorick et al.[15] who suggested myometrial thinning had 79% sensitivity and 77% specificity in diagnosis of placenta accreta.

This study revealed that sensitivity, specificity, PPV, NPV, and accuracy were 47.06, 44, 82.6, 12.9, and 46.6%, respectively, in correlation with histopathological assessment. In addition, our research revealed that sensitivity, specificity, PPV, NPV, and accuracy were 46, 75, 70, 52, and 59%, respectively, in correlation with intraoperative assessment.

Our study agreed with Comstock[16] who stated that placental bulge is not sensitive and but is being specific, where he found it to be a specific sign.

The total pooled sensitivity and specificity from nine investigations of anomalies of the uterobladder
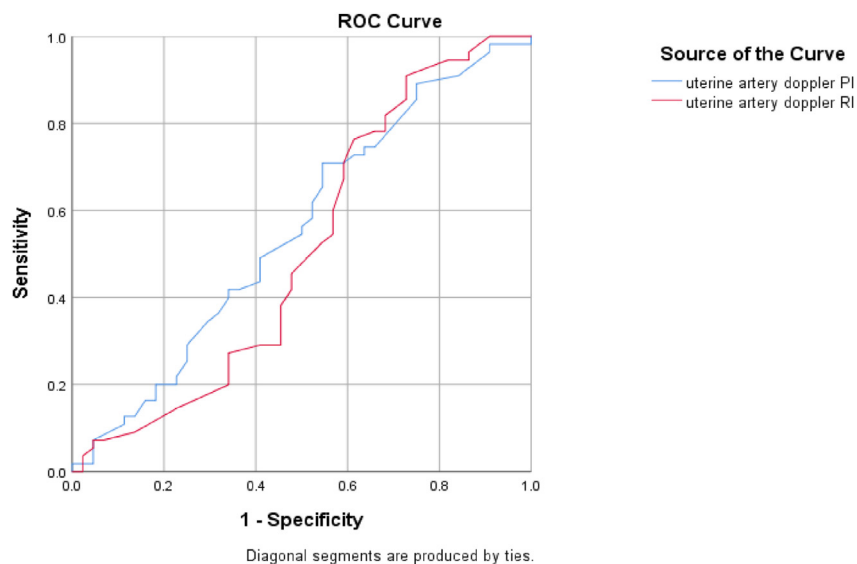

Fig. 1. Receiver operating characteristic curve for prediction of accrete by operative findings using Doppler measures.

interface diagnosing MAP were 49 and 99%, respectively, in a systematic review.[13]

Cali et al.[17] suggested that this criterion showed sensitivity was 70%, specificity was 100%, PPV was 100%, and NPV was 100%. This is unlike Comstock,[18] who found that sensitivity was 20%, PPV was 75%, sensitivity was 11%, and specificity was 100%.

The interruption of this line is caused by increased vascularity in this area, as seen by color Doppler. It does not indicate bladder invasion as interruption may be observed in placenta accreta.[19]

This research revealed that sensitivity, specificity, PPV, NPV, and accuracy were 82, 33, 87, 25, and 75%, respectively, in correlation with histopathological assessment. In addition, our research revealed that sensitivity, specificity, PPV, NPV, and accuracy were 83, 70, 78, 77, and 78%, respectively, in correlation with intraoperative assessment.

Our study did not agree with Pilloni et al.[10] where it showed 10.8% sensitivity and 98% specificity.

Our findings backed with a previous comprehensive analysis, which found that the total pooled sensitivity and specificity from 12 investigations using color Doppler anomalies identifying MAP were 90 and 89%, respectively.[14]

Our study agreed with Cali et al.[17] who showed sensitivity was 90%, specificity 100%, PPV 100%, and NPV 97%.

Our study agreed with Cali et al.[17] who showed sensitivity was 39%, but did not agree regarding specificity, as they showed specificity was 100%. Our study did not agree with Comstock and Bronsteen[20] who showed that the bridging vessels had sensitivity, specificity, PPV, and NPV of 89, 96, 80, and 98%, respectively.

Our results showed no statistically significant correlation regarding average values of uterine artery Doppler PI and RI between cases of placenta accreta and nonaccreta ($P = 0.078$ and 0.58, respectively) in correlation with histopathological assessment. Our results showed no statistically significant correlation regarding average values of uterine artery Doppler PI and RI between cases of placenta accreta and placenta nonaccreta ($P = 0.341$, 0.953, respectively) in correlation with intraoperative assessment.

A study held by Cho et al.[21] reported that the average uterine artery PI was considerably lower in the placenta accreta group compared with the PP group, which contradicted the findings of the current research, which revealed no such link.

5. Conclusion

The accuracy of abnormal placental lacunae, loss of retoplacental clear zone, myometrial thinning, and uterovesical hypervascularity are the most important US criteria in the diagnosis of placenta accreta in patients who had a previous CS with a PP overlying the previous uterine scar.

Acknowledgment

Conflict of interest

There are no conflicts of interest.

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